Space Technology Research Grants

Integrated Submillimeter-Wave InP HBT Electronics for Atmospheric Radiometry

Completed Technology Project (2016 - 2017)

Project Introduction

The goal of this research is to improve the accuracy, sensitivity, and stability of a 325 GHz submillimeter-wave radiometer for ice cloud imaging. The study of clouds and precipitation systems advance our understanding of the atmosphere and global climate change. This study seeks to demonstrate components that improve on the performance of commercially available components, develop components that do not exist, and demonstrate the ability to integrate multiple components in a compact package. Recent advancements in semiconductor fabrication have enabled improvements of active and passive components in the submillimeter-wave range. Indium phosphide heterojunction bipolar transistors are a promising technology in the development of terahertz frequency active components for submillimeter-wave radiometry. We will use the 130-nm indium phosphide (InP) double heterojunction bipolar transistor (DHBT) process developed by Teledyne Scientific. Terahertz monolithic integrated circuits (TMICs) can be realized with this process, which enable the design of a compact receiver on a single chip. Over the course of this experience, I will primarily focus on the validation of individual components using the InP DHBT process for future integration. The emphasis will be on the development of the front-end calibration module, terahertz bandpass filter, and RF LNA. The presence of the LNA in the front-end significantly reduces the overall noise figure of the system. Without this stage, the noise figure is primarily dominated by the mixer noise figure and conversion loss, which is currently the limiting factor in submillimeter-wave receiver sensitivity. The front-end filter stage eliminates double sideband ambiguity, which currently limits the channelization of scientific frequency bands of interest. A fast switching internally integrated calibration module will simplify system design, reduce cost, and increase calibration frequency by reducing the need for complicated cold sky calibration pointing maneuvers or costly thermal systems. The component performance will be tested with a 325 GHz heterodyne receiver prototype. Components will then be systematically integrated on a single chip to demonstrate their interconnect performance. The end goal is to produce a fully integrated TMIC that encompasses the front end RF components, LO chain components, and mixer. Individual components developed in this research can also be used to improve the performance of existing NASA missions.

Anticipated Benefits

The goal of this research is to improve the accuracy, sensitivity, and stability of a 325 GHz submillimeter-wave radiometer for ice cloud imaging.

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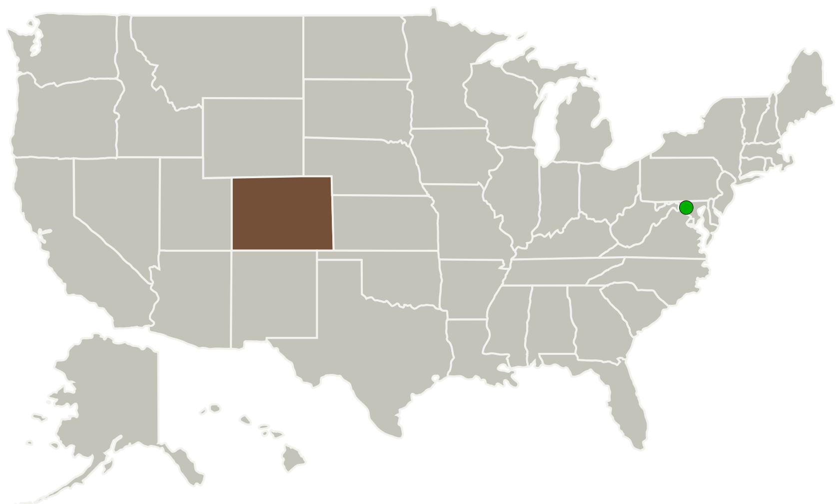
Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
University of Colorado Boulder	Lead Organization	Academia	Boulder, Colorado
Goddard Space Flight Center(GSFC)	Supporting Organization	NASA Center	Greenbelt, Maryland

Primary U.S. Work Locations
Colorado

Project Website:

https://www.nasa.gov/strg#.VQb6T0jJzyE

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Organization:

University of Colorado Boulder

Responsible Program:

Space Technology Research Grants

Project Management

Program Director:

Claudia M Meyer

Program Manager:

Hung D Nguyen

Principal Investigator:

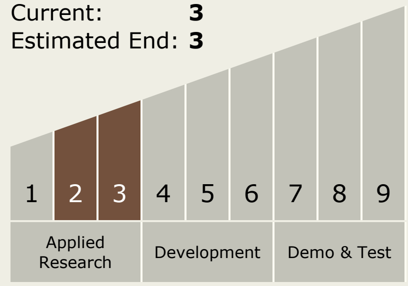
Zoya Popovic

Co-Investigator:

Caitlyn M Cooke

Technology Maturity (TRL)

Start: **2**
Current: **3**
Estimated End: **3**



Technology Areas

Primary:

- TX14 Thermal Management Systems
  - └─ TX14.2 Thermal Control Components and Systems
    - └─ TX14.2.3 Heat Rejection and Storage

Target Destination

Earth